# Measuring Returns And Contagion Of Investor Behavior In Iraq Stock Exchange Using Multivariate GARCH Model

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## Abstract

This paper aims to use multivariate GARCH models (MVGARCH), including the dynamic conditional correlation (DCC-GARCH) model to reveal the nature of the correlations between the returns of Iraqi financial market, and then test the extent of transmission of fluctuations between the financial market sectors. The DCC-GARCH developed by Engle (2002) is used to detect changes occurred in the conditional correlations during the time. The model assumes that the statistical distribution of the time series is the normal with mean equal to zero and conditional variance. The results of the statistical analysis showed that the correlation among banking, services, and industrial sectors is dynamic. This result confirms that the occurrence of previous shocks of the banking sector index will lead to fluctuations in indices of services and industrial sectors of Iraqi Stock Exchange. The results of the Jaque-Bera test confirm that the differences between all sectors are significant because P-value is less than 0.05.

**Key words:** common movement, dynamic conditional correlations, contagion of fluctuations, MV-GARCH, Iraqi Stock Exchange

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## 1. Introduction

Over the past years, there has been increasing concern among investors and economists about the rise in risks in the financial markets. In light of the apparent homogeneity of the transfer of fluctuations between financial markets as interconnected sectors, the diversification of investment portfolios has become a safe haven for investors during periods of uncertainty and increases of volatility (Katzke, 2013). The movement of fluctuations takes two directions in a balanced way. The first direction represents the transfer of those fluctuations within the framework of the same market between the different sectors (Hassan & Malik, 2007), while the second direction takes into account transition between global markets. In our study, we try to evaluate the transmission mechanism of these fluctuations within Iraqi market. There are many previous studies that dealt with the mechanism of transmission within homogeneous and different sectors.

Ewing et al. (2002) introduced a study deals with the mechanism of the transfer of fluctuations between sectors of oil and natural gas in different markets, a time series model has used to examine characteristics for single variable and two variables. Katzke (2013) introduced a study to explore the dynamic relationship between groups of economic sectors in South Africa. The possibility of diversifying investment portfolios has tested to avoid the risks of volatility of the financial markets using bivariate volatility models. Hassan and Malik (2007) used MGARCH-VEC, MGARCH-BEKK models to measure volatility of different sectors in the United States of America for the period 1 January 1992 to 1 January 2005. Hammoudeh et al (2009) conducted a study to assess fluctuations of the financial markets of the Gulf Cooperation Council Countries from two directions which are dynamic volatility and transmission volatility by adopting multivariate conditional volatility models.

Arouri et al 2012 investigated indirect fluctuations between the oil and European financial markets. The VAR-GARCH approach has adopted to track trends' fluctuations. The relationship between fluctuations of oil prices and different sectors of the Gulf Cooperation Council Countries for the period 2006-2017 has measured by Arouri et al. (2019).

This study attempts to build a dynamic model measuring fluctuations of the common returns of the Iraq Stock Exchange during the period January 2005 to December 2020 by using modern statistical and standard methods simulating the reality of the fluctuations which are constantly occurring in Iraqi financial market. Based on the aforementioned literature, it is important to study fluctuations and understand investor behavior in order to reduce the risks of financial investment.

This research aims to use multivariate GARCH models (MVGARCH), including the dynamic conditional correlation DCC-GARCH (model) to reveal the nature of the correlations between the returns that make up Iraqi financial market and test the extent of transmission of fluctuations between financial market sectors during a period of time.

This paper is organized as follows: Section 2 presents preliminaries of the GARCH model. The methodology of multivariate GARCH (MVGARCH) models is illustrated in Section 3. Empirical results and discussion are performed in Section 4. Concluding remarks are finally presented in Section 5.

## 2. Preliminaries of the Generalized GARCH model

The GARCH model has two types of slowdowns and time lags can be captured: (i) the first slowdown related to the the past period which called high frequency reform or fluctuations in a past period (Panda and Nanda, 2018). These fluctuations are measured by the slowdowns of reminder squares, (ii) the second type deals with value of slowing down or lagging the variance itself to capture long-term fluctuations. In GARCH model (1), variance appears as a combination of long-term variance and past period variance. The past period variance represents a kind of response that depends on size of shocks were occurred in the past. The GARCH model can be presented as follows:

$$\varepsilon_t = v_t\sqrt{h_t}\ , \quad \text{where} \quad \sigma_v^2 = 1 \qquad (1)$$

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 \qquad (2)$$

$$h_t = \alpha_0 + \sum_{i=1}^{q} \alpha_1 \varepsilon_{t-1}^2 + \sum_{i=1}^{p} \beta_i h_{t-1} \qquad (3)$$

Where $v_t$ denotes the noise limit of the random error distribution which is usually independent on the past period errors; i.e., $\varepsilon_{t-1}^2$ , $h_{t-1}$ represent the conditional variance of the error distribution.

## 3. Methodology

Multivariate GARCH (MVGARCH) models have several forms, including the model utilised in this paper, which is the DCC-GARCH (Dynamic Conditional Correlation) developed by Engle (2002). The model aims to detect changes occurred in the conditional correlations during the time and does not have any bias towards fluctuations of the money markets. In addition, it can constantly modify the correlation of fluctuations during the time (Cho & Parhizgari, 2009). The model of this paper assumes that the statistical distribution of the time series is normal distribution with a mean of zero and conditional variance.

Multivariate (MVGARCH) models are defined as in the following mathematical formula:

$$r_t = \mu_t + a_t \qquad (4)$$

$$a_t = M_t^{\frac{1}{2}} Z_t \qquad (5)$$

where $r_t$ is a return vector at time $t$

*t*return vector of mean to relatedis the time $a_t$

error vectora series of is $z_t$

$\mu_t$ the expected value of conditional return vector

$M_t$ conditional covariance matrix

$$M_t = V_t F_t V_t \qquad (6)$$

where , $V_t$ is a diagonal matrix of conditional standard deviations

$$V_t = \begin{bmatrix} \sigma_{1t} & 0 & \ldots\ldots & 0 \\ 0 & \sigma_{2t} & \ldots\ldots & 0 \\ . & . & . & \\ . & . & . & .. \\ 0 & \ldots\ldots. & . & \sigma_{nt} \end{bmatrix} \qquad (7)$$
$$= Diag(\sigma_{1t}, \sigma_{2t}, \ldots, \sigma_{nt})$$

$F_t$ is the array of conditional links

$$F_t = (diag(Q))^{1/2}\, Q_t (diag(Q))^{-1/2}) \qquad (8)$$

where $Q_t = (q_{ij.t})$ is the conditional variance matrix that can be and written as follows:

$$Q_t = (1-\alpha-\beta)\bar{Q} + \alpha(e_{t-1}e'_{t-1}) + \beta Q_{t-1} \qquad (9)$$

$\bar{Q}$ is the matrix of unconditional variances

$\alpha, \beta$ is the model parameters

The dynamic conditional correlation coefficient can be written as follows:

$$\rho_{ij.t} = \frac{qij.t}{\sqrt{q_{ii.t}}\sqrt{q_{jj.t}}} \qquad (10)$$

This paper attempts employ two types of univariate models, namely, GARCH model to measure the fluctuations of return. The second model is DCC-MGARCH which can be used to assess the conditional interconnection between the different sectors in Stock Exchange of Iraq.

## 4. Empirical results

This paper utilises data set of Stock Exchange in Iraq for the period January 2005 to December 2020, and the main sectors. The DCC model is used to test the dynamic movement and conditional linkages between banking sectors and other sectors (Insurance, Investment, Services, Industry, Tourism, and Agriculture). All calculations of measures were performed using Eviews Software. To provide a picture of analytical descriptive of the data set, statistical measures are calculated as shown in Table 1.

Table 1
Descriptive statistics of the stock returns

| Sectors | Banking | Agriculture | Industry | Insurance | Investment | Service | Truism |
|---|---|---|---|---|---|---|---|
| Sector returns | BAN_R | AGR_R | IND_R | INS_R | INV_R | SER_R | TOU_R |
| Mean | -0.46 | 5.26 | 16.79 | 1.19 | 1.40 | 2.84 | 2.20 |
| Median | -1.82 | -0.54 | -1.26 | 0.00 | 0.00 | 0.61 | -1.07 |
| Maximum | 78.11 | 276.00 | 891.06 | 113.64 | 102.70 | 94.16 | 282.90 |
| Minimum | -48.83 | -78.72 | -89.84 | -56.99 | -63.81 | -61.43 | -71.17 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Std. Dev.** | **17.25** | **37.40** | **91.08** | **20.82** | **22.74** | **24.47** | **30.41** |
| **Skewness** | **1.58** | **2.83** | **5.69** | **1.20** | **1.07** | **0.90** | **4.75** |
| **Kurtosis** | **9.29** | **18.62** | **50.53** | **7.92** | **7.10** | **5.00** | **42.73** |
| **Jarque-Bera** | **369.72** | **2058.99** | **17812.30** | **223.67** | **159.29** | **53.82** | **12443.16** |
| **Probability** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** |

Table 1 presents that the stock returns for all considered sectors are not distributed as normal distribution. Also, the test confirms that there significant differences among all sectors' results, because P-value is less than 0.05. The results release a large fluctuation between the values of stock returns of all sectors. A clear fluctuation between the average returns of stocks, where the lowest average of banking sector is 0.46, while the highest average of the industrial sector is 16.79. The values of the torsion coefficient of the stock returns values of all sectors are positive. This indicates that the distribution of the sectors is a curvature on the right side, while we can observe that the value of the sputter coefficient is greater than 3. This indicates that the stock returns of these sectors take a thick and elongated shape.

To ensure that the time series of all stock returns of all sectors is stable, self-regression models have to apply. The aim of applying self-regression models is to detect the lack of homogeneity of variance. In addition, tests of unit root are examined and their results are shown in Table 2.

Table 2
Results of unit root tests of stock returns

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | **UNIT ROOT TEST TABLE (PP)** | | | | | |
| | **At Level** | | | | | | |
| | | **BAN_R** | **AGR_R** | **IND_R** | **INV_R** | **SER_R** | **TOU_R** |
| **With Constant** | **t-Statistic** | **-19.833** | **-16.617** | **-16.674** | **-20.384** | **-18.602** | **-18.178** |
| | **Prob.** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** |
| | | ******* | ******* | ******* | ******* | ******* | ******* |
| **With Constant & Trend** | **t-Statistic** | **-19.909** | **-17.085** | **-16.897** | **-20.335** | **-18.547** | **-18.413** |
| | **Prob.** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** |
| | | ******* | ******* | ******* | ******* | ******* | ******* |
| **Without Constant & Trend** | **t-Statistic** | **-20.032** | **-16.081** | **-15.607** | **-19.564** | **-18.152** | **-18.004** |
| | **Prob.** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** |
| | | ******* | ******* | ******* | ******* | ******* | ******* |
| | | **UNIT ROOT TEST TABLE (ADF)** | | | | | |
| | **At Level** | | | | | | |
| | | **BAN_R** | **AGR_R** | **IND_R** | **INV_R** | **SER_R** | **TOU_R** |
| **With Constant** | **t-Statistic** | **-18.866** | **-16.663** | **-16.403** | **-18.456** | **-17.806** | **-17.746** |
| | **Prob.** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** |
| | | ******* | ******* | ******* | ******* | ******* | ******* |
| **With Constant & Trend** | **t-Statistic** | **-18.923** | **-16.847** | **-16.477** | **-18.407** | **-17.756** | **-17.807** |
| | **Prob.** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** |
| | | ******* | ******* | ******* | ******* | ******* | ******* |
| **Without Constant & Trend** | **t-Statistic** | **-18.890** | **-16.305** | **-15.772** | **-18.404** | **-17.519** | **-17.678** |
| | **Prob.** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** |
| | | ******* | ******* | ******* | ******* | ******* | ******* |
| **Notes: (*) Significant at 10%; (**) Significant at 5%; (***) Significant at 1%. and (no) Not Significant** | | | | | | | |

***MacKinnon (1996) one-sided p-values.**

The results reported in Table 2 reflect that the time series is stable at the original level of all sectors' returns, as such that of Phillips-Perron and the Dickie-Fuller tests. These tests showed that condition of applying ARCH models is significant. In order to identify the existence of conditional correlations between the returns of the shares of each sector, primarily of shares movement of each sector during the period is studied. For this, it is obvious that there is a strong correlation between the returns of shares of each sector.

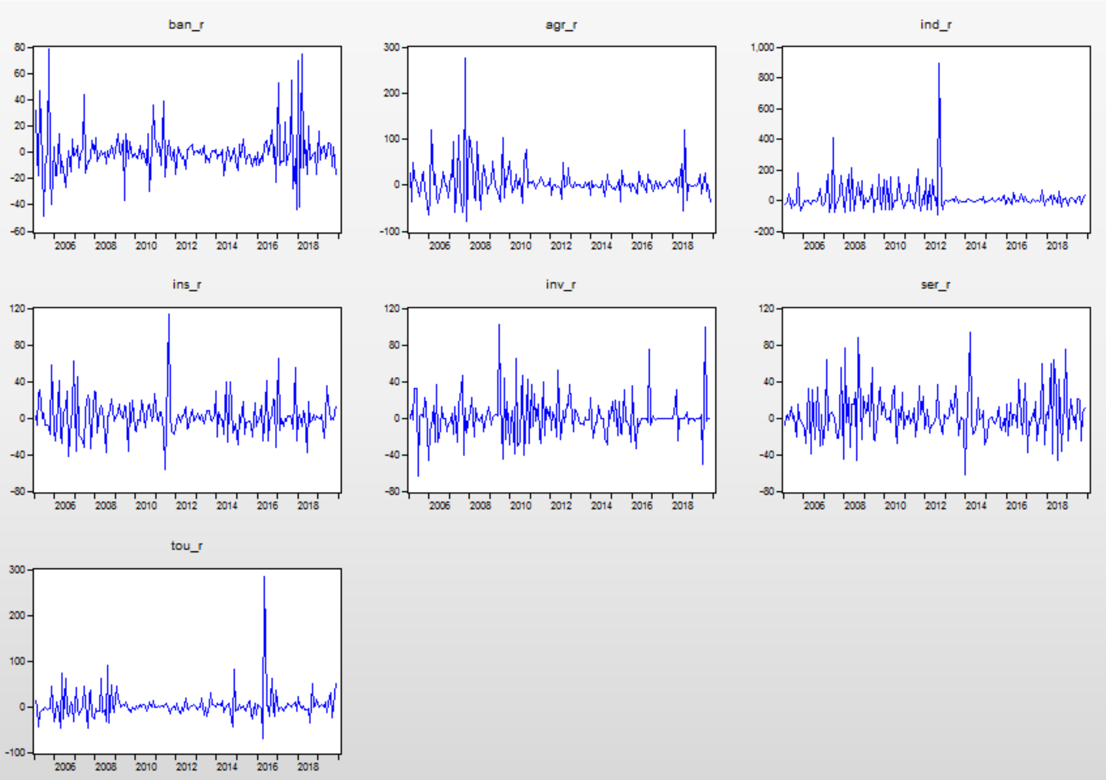


Figure 1 development of revenue indicators and dynamic conditional links

Due to the relationship between stock returns of each sector has tested, measures of the GARCH models are estimated as shown in Table 3.

Table 3

Results of GARCH models

| Variance equation | BAN | AGR | IND | INV | SER | TOU | INS |
|---|---|---|---|---|---|---|---|
| Costant | 13.592* | 50.422* | 2.567* | 381.053* | 74.351* | 87.074* | 86.283* |
| ARCH(∝) | 0.277* | 0.900* | 1.452* | 0.276* | 0.128* | 0.993* | 0.517* |
| GARCH(β) | 0.712* | 0.423* | 0.475* | 0.111* | 0.743* | 0.228* | 0.396* |
| Sum of (∝+β) | 0.989 | 1.323 | 1.927 | 0.387 | 0.871 | 1.221 | 0.913 |

Source: Oxmetrics output

Significant differences at the level of 5% are revealed by *

It is obvious from the results presented in Table (3) that all stock returns of all sectors have significant differences at probability level which is 5%. This indicates that there is an influence of previous errors and conditional variance of past returns on future returns of sectors. Therefore, resulted values of the ARCH coefficient for all sectors are larger than values of the GARCH coefficient, except for the banking and services sector. This indicates that renewable information of each sector has more impact on the sector than old information. The sum of the sectors' variance components also shows that each sector (agriculture, industry, tourism) has a high volatility which is continuous and greater than 1. Hence, we can observe that volatility is increased over the time, while the sectors (banks, investment, and services) have volatility less than 1, indicating that the fluctuations of the returns of these sectors may reduce over the time. This result is consistent with the economic analysis because the sectors have continuous fluctuation on the time which can be characterized by volatility as a result of their strong connection with the economic environment and surrounding conditions. Due to the war on terror and forced displacement during the period 2004 to 2017, lack of water resources, agricultural, and dumping policies from neighboring countries are occurred.

The conditional correlation model DCC-GARCH is estimated for each sector as shown in Table 4.

Table 4
Results of the GARCH model and DCC-assessment for all sectors

| model | AGR | IND | INV | SER | TOU | INS |
|---|---|---|---|---|---|---|
| **rho** | **0.091** | **0.225*** | **0.086** | **0.144** | **0.147** | **0.117** |
| **alpha** | **0.001** | **0.201** | **0.019** | **0.151** | **0.175** | **0.199** |
| **beta** | **0.801** | **0.054** | **0.377** | **0.001** | **0.001** | **0.280** |
| **Alpha and beta** | **0.802** | **0.255** | **0.396** | **0.152** | **0.176** | **0.479** |

Source : Oxmetrics output
* Indicates significant differences at the level of 5%

Results presented in Table 4 show that the DDC between the returns of the banking sector and the rest of other sectors over the time are positive values. This means that the fluctuations occurred in the banking sector lead to fluctuations in the industrial sector, while a weak dynamic relationship between banking sector and rest of other sectors is observed. Table 4 presents values of sum of (alpha and beta) which are positive. This result ensures that the continuity and dynamism in the kinetic conditional correlations in the long term is existence.

## 5. Conclusions

The aim of this research is to employ multivariate GARCH (MVGARCH) models, including the DCC-GARCH model to reveal the nature of correlations between the returns of Iraqi financial market, and then test the extent of transmission of fluctuations between the financial market sectors. Torsion coefficient values of the stock returns for all sectors are positive. This indicates that the distribution of the torsion sectors is on the right side, while we find that the value of the flattening coefficient is greater than 3. Hence, the shape of stock returns of these sectors is thick and elongated. Moreover, results of the GARCH models illustrate that the values of the ARCH coefficient for all sectors are greater than that of the GARCH coefficient, except sectors of banking and services. This indicates that the renewed information of each sector has more impact on the sector than the old information. The stock returns of the rest considered sectors are not follow the normal distribution, as the results of the (Jaque-Bera) test confirmed that the differences between all sectors are significant because P-value is less than 0.05, also a large fluctuation between the value of stock returns for all sectors is revealed. This paper presents that the used time series of all sectors are stable at the original returns level. Tests of Phillips-Perron and Dickie-Fuller show that differences between the basic conditions of applying ARCH models are significant. On the other hand, results of the dynamic correlation reveal that the fluctuations occurred in the banking sector lead to fluctuations in the industrial sector, while the relationship between the banking sector and the rest sectors is weak dynamic. This gives an indicator that risks of forming investment portfolios in the case of forming an investment portfolio have been reduced. It is worth noting that the hypothesis of this study is not proven, reflecting that the fluctuations in the banking sector did not reflect in the rest sectors.

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